

BACTERIA TAKE OVER AND DOWN

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Subject: Chemistry/Biology

Grade Level: 9-12

Standards: Next Generation Science Standards (www.nextgenscience.org)

Take-Over-

MS-LS1-5. Growth, Development, and Reproduction of Organisms

Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

HS-LS1-7 .Matter and Energy in Organisms and Ecosystems

Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed, resulting in

LS1.C: Organization for Matter and Energy Flow in Organisms

As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.

HS-PS1-5 Matter and its Interactions

Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

Take-Down-

MS-PS1-3. Structure and Properties of Matter

Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

MS-LS1-5. Growth, Development, and Reproduction of Organisms

Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

LS1.C: Organization for Matter and Energy Flow in Organisms

As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.



HS-PS1-1 Matter and its Interactions

Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

HS-PS1-2 Matter and its Interactions

Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

HS-PS1-5 Matter and its Interactions

Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

Schedule (Bacteria Take-Over):

Night Before: Prepare agar solution and store in refrigerator.

Period 1 [best if this is the first period in a two period block](40 minutes):

- Reading through lab background and procedure. (10 minutes)
- Gathering of supplies and beginning the lab procedure (30 minutes)

Period 2 [best if this is the second period in a two period block](40 minutes):

- Plating of bacteria.
- Writing down of initial observations and hypotheses.

Continue making observations of both the controlled petri dish and the metal submerged petri dishes for the next four to six days. After the four to six days are complete gather all the data together as a class and analyze to see what are the best and worst sources for bacteria growth. At least half a period extra should be designated for classes to compare results with other lab groups.

Schedule (Bacteria Take-Down):

As an option students can read the paper on metals in medicine found [here](#).

Night Before: Prepare agar solution and store in refrigerator.

Period 1 [best if this is the first period in a two period block](40 minutes):

- Reading through lab background and procedure. (10 minutes)
- Gathering of supplies and beginning the lab procedure (30 minutes)

Period 2 [best if this is the second period in a two period block](40 minutes):

- Plating of bacteria.
- Adding of metals to appropriate locations on petri dish.
- Writing down of initial observations and hypotheses.

Continue making observations of both the controlled petri dish and the metal submerged petri dishes for the next four to six days. After the four to six days are complete gather all the data together as a class and analyze to see what metals have the largest and smallest effects on bacterial growth as compared to the controlled.

At least half a period extra should be designated for classes to compare results with other lab groups.

CCMR Lending Library Connected Activities:

<p>Objectives: Take-Over- Students will be able to observe the prevalence of bacteria in maintaining of good health through an interactive lab experiment.</p> <p>Take-Down- Students will be able to better understand the use of metals in medicinal chemistry and antibacterials.</p>	<p>Vocabulary: Take-Over-</p> <ul style="list-style-type: none"> - Bacteria - Binary fision - Virus - Fungi - Mold - Growth - Cells - Microorganisms - nucleus membrane - DNA <p>Take-Down-</p> <ul style="list-style-type: none"> - Bacteria - Binary fision - Virus - Fungi - Mold - Metals - Growth - Cells - nutrient
<p>Students Will: Take-Over-</p> <ul style="list-style-type: none"> - Complete an experiment in which they observe the growth of bacteria of different source regions <p>Take-Down-</p> <ul style="list-style-type: none"> - Complete an experiment in which they observe the growth of bacteria in a controlled environment to see if certain metals can affect the growth and prosperity of certain bacteria. 	<p>Materials: Take-Over-</p> <ul style="list-style-type: none"> - petri dishes (1-2 per group) - Nutrient agar powder (or agar powder and beef bouillion cube) - heater or incubator - cotton swabs - hand sanitizer - marker for labeling - liquid bleach - lab safety gloves <p>Take-Down-</p> <ul style="list-style-type: none"> - petri dishes (atleast 2 per group) - Nutrient agar powder (or agar powder and beef bouillion cube) - heater or incubator - cotton swabs - vinegar - hand sanitizer



	<ul style="list-style-type: none"> - masking tape and marker for labeling - penny, nickel, quarter, aluminum foil, and other miscellaneous metals for testing. - liquid bleach - lab safety gloves
<p>Safety</p>	<ul style="list-style-type: none"> - Make sure that all bacteria is contained and that hands are always washed before and after working with samples. - Make sure that bacteria is dead before disposing of it by washing it down the sink. This can be done by using bleach. - Wearing rubber gloves, goggles, and an apron or lab coat is advised while completing this experiment (especially depending on metals used).

Science Content for the Teacher:

Quite often illnesses and diseases can be caused by the transmittance of some sort of microorganism. These different microorganisms could vary from some sort of virus, fungi, or bacteria. These little invaders use the nutrient rich and warm human body to prosper and to replicate themselves (Alberts, Johnson, & Lewis). The surplus of these invaders is often what will cause a person to become ill. Therefore it is the medicines that we take that will play a role in affecting the life and growth of these microorganisms, and in some cases these organisms can even be killed off by the medicines that we take.

Medications can be made of of many things. One ingredient found in many medicines, as weird as it may sound, are different types of metals. “Not only the 24 or so essential elements, but also nonessential and even radioactive elements have enormous potential for applications in medicine. In the fight against cancer cisplatin, one of the world’s best selling anticancer drugs, is being joined by other platinum, titanium, and ruthenium complexes” Gadolinium(III) complexes can be safely injected as magnetic resonance imaging [MRI] contrast agents, and ligand design allows targeting of paramagnetic ions as well as radiodiagnostic (e.g. ^{99m}Tc) and radiotherapeutic isotopes (e.g. ¹⁸⁶Re). Manganese superoxide dismutase mimics, vanadium insulin mimics, ruthenium nitric oxide scavengers, lanthanide-based photosensitizers, and metal-targeted organic agents show exciting clinical potential” . Also in more common uses of medicine “Inorganic bismuth derivatives have good antibacterial properties and are considered to be only slightly toxic to humans because of their low uptake into human cells. Compounds containing bismuth [such as pepto-bismol] are therefore widely used in medical applications. Bismuth-containing pharmaceuticals, partially in synergy with antibiotics, are already used or are being considered in the treatment of infections caused



by certain bacteria, especially to eradicate *Helicobacter pylori*, *Pseudomonas aeruginosa*, *Burkholderia multivorans* and *B. cenocepacia*” (Thomas, Bialek, & Hensel).

Classroom Procedure:

Prepare the Agar Plates-

1. Prepare the agar fluid. The easiest type of agar to use for this experiment is a nutrient agar which comes in powder form (if you do not have nutrient agar you can use regular agar powder or gelatin powder and add in a beef bouillon cube for bacteria nutrients). You will need as much agar as you need, but don't use less than 1.2 grams (approximately half a teaspoon) of agar powder for every 4-inch petri dish you wish to use. In a heat proof dish, bowl, or beaker, stir half a teaspoon of the nutrient agar powder into 60 ml (approximately 1/4 cup) of hot water. Multiply these quantities for however many petri dishes you plan on using. Place the bowl or dish in the microwave (if using a beaker place on a hot plate and bring to a boil) and begin to boil for one minute, watching to make sure that the agar solution doesn't boil over and stir continuously to ensure that the agar does not stick to the bottom of the beaker. When the solution is ready, the agar powder should be completely dissolved and the liquid should be a light tan or slightly brown in color and should be liquid enough to pour. Allow the agar solution to cool for several minutes before proceeding
2. Retrieve un-opened, sterilized (or as sterile as you can get) petri dishes (atleast 2 per lab group)
3. Pour the agar fluid into the bottom of the petri dish (just enough to cover the bottom of the petri dish. Quickly replace the cover to prevent from the contamination of some other unwanted airborne bacteria.
4. Set the petri dishes aside for 30 minutes to 2 hours, until the agar solution cools and hardens (when it is ready it will resemble a hardened version of set Jell-O).
5. Refrigerate the petri dishes until ready to use. If you don't plan on using the agar-filled petri dishes immediately, they should be stored in the refrigerator until you are ready to proceed with the experiment. Storing the petri dishes in the refrigerator prevents the water inside the dishes from evaporating (bacteria need a moist environment to grow). It also allows the surface of the agar to harden slightly, which prevents any tearing or gouging when you transfer your bacteria samples. When storing petri dishes in the refrigerator, the dishes should be placed upside down. This helps to prevent any condensation on the lid from dropping down and disrupting the growing surface. Agar-filled petri dishes will keep in the refrigerator for as long as a couple of months. When you are ready to use them, remove them from the refrigerator and allow them to reach room temperature before introducing your samples.
6. See lab procedure as in student activity sheet
7. Place the petri dishes in a warm, dark place (incubation system is ideal). Leave



the petri dishes in a warm, dark place where the bacteria can develop, undisturbed, for several days. The ideal temperature for growing bacteria is around 98° F (37 °C). If necessary, you can place the petri dishes in a cooler location, but the bacteria will grow a lot slower. Leave the bacteria to develop for 4-6 days, as this will give the cultures enough time to grow. Once the bacteria begins to grow, you may notice a smell coming from the dishes. Below are two different options for relatively cheap incubation systems.



https://www.tractorsupply.com/tsc/product/little-giant-still-air-incubator-2167379?cm_mmc=feed-_-GoogleShopping-_-Product-_-2167379&gdfi=71ecb2c5669d4bfa8a12ad37b4753469&gdfms=98741BF2F14345528CF39E063019A914&gclid=EAJaIQobChMIu4X0gLfK1QIVQkOGCh1qTgAfEAkYASABEGLFMfD_BwE



Above is a plastic fish tank lined with black construction paper with a lamp suspended above it. It is also possible to place a tank such as this on a heater. Just be cautious that the heater does not get too hot.

8. Leave the petri dishes in their warm dark place for 4-6 days, checking on them each day and writing down observations based of their appearance, smell, and size. Make sure to differentiate between the bacteria of the controlled plate versus the metal plate.
9. After the 4-6 days record your final observations and compare your results with the rest of the class to create a data table that displays the way that these metals inhibited your results.

Assessment:

- Completion of the lab procedure, data table, discussion questions, and conclusion questions..

Resources:

- Article on metals used in Medicine (for pre-experimental background)
http://authors.library.caltech.edu/25052/10/BioinCh_chapter9.pdf
- Paper on Research Findings at the Cornell University Wilson lab group (as an extension article)

Extra Activities (Extensions):

Take Over

- Explore some different methods of inhibiting bacterial growth. Try plating bacteria using these different methods and see if it affects your bacteria growth.
- How well does toothpaste kill bacteria on your teeth? Swab bacteria onto a plate before and after brushing your teeth to see if there's a difference.
- Metals are often used in medicine. Try using petri dishes to plate bacteria and introduce different metals into their environment to see how it affects the growth and development of the bacteria.
- Complete research to try and identify the bacteria you have grown.
- Using a microscope use the link below to identify the bacteria you have grown.
<http://microbiologyonline.org/teachers/observing-microbes/observing-bacteria-in-a-petri-dish>

Take Down-

- Explore some different methods of inhibiting bacterial growth. Try plating bacteria using these different methods and see if it affects your bacteria growth.
- How well does toothpaste kill bacteria on your teeth? Swab bacteria onto a plate before and after brushing your teeth to see if there's a difference.
- Metals are often used in medicine. Try using petri dishes to plate bacteria and introduce different metals into their environment to see how it affects the growth and development of the bacteria.
- Complete research to try and identify the bacteria you have grown.
- You know that certain metals can hinder the growth of bacteria, but can they kill bacteria. Try this experiment again, but this time introduce the metal after the bacteria has shown significant growth to see if the metal is able to kill of the already grown bacteria.
- Coins have been made out of different combinations of different metals over the years. Test how coins of different ages would affect bacterial growth.



Acknowledgements:

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